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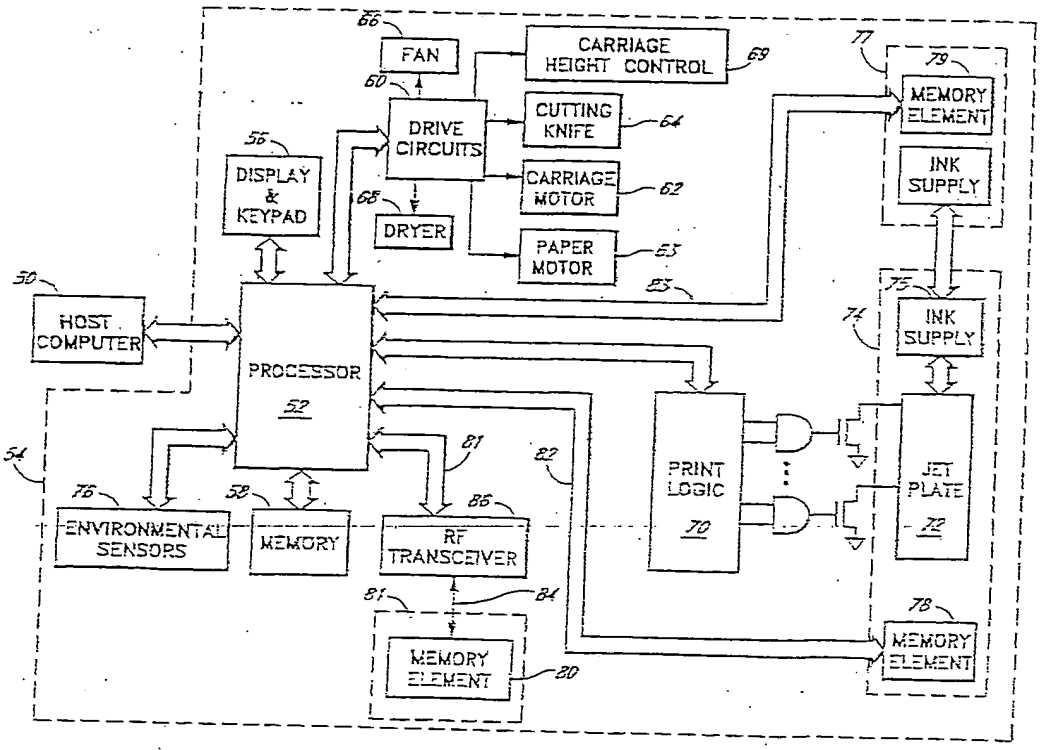
(54) Title: INTELLIGENT PRINTER COMPONENTS AND PRINTING SYSTEM



(57) Abstract

An ink jet printer with intelligent components includes an ink jet cartridge (74) and a roll of print media (81), each of which incorporate memory elements (78, 80). Environmental sensors (76) such as temperature and humidity sensors may also be provided. Data from the memory elements (78, 80) and environmental sensors (76) is used to optimize printer operations, and to provide additional information to printer operators.

INTELLIGENT PRINTER COMPONENTS AND PRINTING SYSTEM

Background of the Invention

1. Field of the Invention

The invention relates to ink jet printers and consumable components used with them.

2. Related Art

Recently, ink jet printers have become widely used in the graphic arts industry. This has been mainly due to continuing increases in quality and throughput achievable with ink jet printers at a cost which is competitive with more traditional graphic arts production processes.

It can be appreciated that many different parameters affect the print quality achievable in ink jet printing. These parameters include ambient environmental conditions such as temperature and humidity. Also, the type of ink and type of media affect the results of the print process. In currently available ink jet printers, the user must consider these various parameters and adjust printer operation accordingly in order to maximize print quality. Although an experienced user of such printers can produce high quality prints, and maximize print speeds, considerable training and experience is required to optimize print operations.

Some efforts have been made to address this problem. For example, a small amount of intelligence has been built into ink jet printer components, most commonly the ink cartridge itself. In these systems, information such as ink color, remaining ink volume, nozzle information, etc. is provided to the printer from a memory element on the ink cartridge itself.

In some proposed printing systems, selected aspect of a printer's configuration are automatically controlled based on sensed environmental conditions. One such system is described in U.S. Patent No. 5,617,516 to Barton. In this patent, some "operational subroutines" such as the frequency of printhead wiping and flushing are varied depending on current temperature and humidity values. U.S. Patent No. 5,428,379 to Kaneko, et al. describes a system using fuzzy logic to control printer operation in accordance with several sensed parameters.

Summary of the Invention

The present invention includes a printer having one or more intelligent components. With this system, the interaction between the ink, the media being printed on, and the environment are more fully addressed. Furthermore, the present system provides the user with desirable information regarding the status of the print job being performed, producing a more comprehensive printer optimization system than has been previously available.

The intelligent components advantageously allow automatic and/or easy manual printer optimization as well as feedback to the printer operator regarding print states, run time, etc. A printing system according to one aspect of the present invention thus retrieves information concerning ink and media characteristics as well as environmental parameters to automatically adjust aspects of the printing process in order to maximize print quality and optimize print speeds while reducing the required set up time and user training and education.

In one advantageous embodiment, the roll of media to be printed on has embedded intelligence in the form of a memory element, and the invention comprises an ink jet printer having a roll of media mounted thereon, wherein the roll of media comprises a memory element. Because the roll of media is in motion during the printing process,

Figure 2 is a schematic/block diagram of one embodiment of an ink jet printer according to one aspect of the present invention.

Figure 3 is a perspective view of a portion of a cartridge including a memory element according to one aspect of the present invention.

Figure 4 is a perspective view of a portion of a second embodiment of a cartridge including a memory element according to one aspect of the present invention.

Figure 5 is a perspective view of a portion of a third embodiment of a cartridge including a memory element according to one aspect of the present invention.

Figure 6 is a top view of a flex circuit adapted for attachment to a print carriage and including a two wire electrical interface for printer communication with the memory element illustrated in Figure 4.

Figure 7 is a perspective view of a print carriage showing a "drop & click" cartridge receptacle having the flex circuit of Figure 5 attached thereon.

Figure 8 is a front view of the print carriage of Figure 6.

Figure 9 is a perspective view of an end of a roll of paper media incorporating an embedded memory element.

Detailed Description of the Invention

Preferred embodiments of the present invention will now be described with reference to the accompanying Figures, wherein like numerals refer to like elements throughout. The terminology used in the description presented herein is intended to be interpreted in its broadest reasonable manner in accordance with its ordinary use in the art and in accordance with any overt definitions provided below.

The present invention is advantageously applied to ink jet printers. Accordingly, an overall description of a typical contemporary large format ink jet printer as manufactured by Encad Inc., assignee of this patent application, is first described with reference to Figure 1. Referring now to this Figure, a printer carriage assembly 10 is supported on the top face of a printer housing 12, which is a part of a typical printer device. The housing 12 is supported by a pair of legs (not shown) and encloses various electrical and mechanical components related to the operation of the printer/plotter device.

A pair of roll holders 14 are mounted to a rear side 16 of the housing 12 and are slidable to accept media rolls of various widths. The roll of continuous print media (not shown in this Figure) is mounted on the roll holders 14 to enable a continuous supply of paper to be provided to the printer/plotter carriage assembly 10. Otherwise, individual sheets of paper may be fed into the rear side 16 of the housing as needed. A portion of a top side 17 of the housing 12 forms a platen 18 upon which the printing/plotting is performed by select deposition of ink droplets onto the paper. The paper is guided from the rear side 16 of the housing 10 under a support structure 20 and across the platen 18 by a plurality of drive rollers 19 which are spaced along the platen 18.

The support structure 20 is mounted to the top side 17 of the housing 12 with sufficient clearance between the platen 18 and the support structure 20 along a central portion of the platen 18 to enable a sheet of paper which is to be printed on to pass between the platen 18 and the support structure 20. The support structure

with the jet plate 72. This small reservoir 75 may be in communication with a large remote ink reservoir 77. The large reservoir 77 may be integral with the printer housing, or may be a user replaceable reservoir which allows swapping different ink colors or compositions. Many implementations of large volume ink reservoirs and their interconnection to ink jet cartridges are known to those of skill in the art. Some of these are described, for example, in U.S. Patent No. 5,686,947 to Murray et al. and 5,389,429 to Erickson. User swappable large volume reservoirs are described in Provisional Application Serial No. 60/036,547. The disclosures of each of these documents are hereby incorporated by reference in their entirety.

In addition to the items set forth above, the processor also advantageously interfaces with environmental sensors 76, which preferably include either or both a temperature and a humidity sensor. One embodiment of the temperature sensor is an electronic temperature sensor which has a digital output indicative of the temperature of the device. Suitable temperature sensors of this nature are commercially available from Dallas Semiconductor as, for example, part number DS1820. Measuring both temperature and humidity allows a computation of the dew point at print time, and this allows a computation of ink dry time, which in turn can be used to set print speed such that adequate drying time is allowed for each print pass of the carriage 22 across the media.

In addition, the processor preferably communicates with a memory element 78 on each ink jet cartridge 74, a memory element 79 on each large volume ink reservoir 77, and a memory element 80 attached to the roll of media (indicated by dashed line 81 on Figure 2) being used to supply the substrate being printed on. The information from the memory elements is communicated to the processor via communication links 81, 82, and 83, which may take a variety of forms. As will be explained in more detail below with reference to Figures 3 through 5, the memory element on the cartridge may comprise simply a trace configuration on a flex circuit provided on the ink jet cartridge. In this embodiment, the trace configuration defines a multi-bit binary code which may be interpreted by the processor. Alternatively, the memory element may comprise an integrated circuit memory which may interface with the processor via a two wire electrical interface which allows both reading from and writing to the memory element 78 by the processor 52. The same alternatives may be suitable for the memory element 79 on the large volume ink reservoir 77.

Because the roll of media on the printer is in motion during the print process, the interface to the memory element 80 on the media roll advantageously includes a wireless link 84 which is driven by RF transceiver circuitry 86 integral to the ink jet printer stand (not shown). This and alternative interfaces to the memory element 80 on the roll of media are described in more detail below with reference to Figure 9.

A perspective view of a portion of an ink jet cartridge according to one aspect of the present invention is shown in Figure 3. An ink jet cartridge 90 includes a housing 92 having a bottom surface 94 which provides a mounting surface for the jet plate 72 (also illustrated in Figure 2). The jet plate 72 is connected to a piece of flex circuit 100 which extends from the bottom surface 94 of the cartridge 90 around a corner to the rear surface 96 of the cartridge. Circuit traces (not shown) connect the jet plate 72 to contacts 97 which mate with contacts on the print carriage so as to connect the printer electronics with the jet plate. In the embodiment illustrated in Figure 3, the memory element 78 comprises a multi-bit binary code defined by a trace configuration. In this embodiment,

Referring now to Figures 6 through 8 in addition to Figures 4 and 5, the ink jet cartridge rear surface 96 includes a carriage interface portion 98, indicated in Figures 4 and 5 by a dashed line on the rear surface 96 of the cartridge 90. The carriage interface portion 98 of this flex circuit 100 makes contact with another flex circuit 110, illustrated in Figure 6, which is mounted to the print carriage. The carriage mounted flex circuit 110 thus includes a printer I/O portion 112 at one end, and a cartridge interface portion 114 at the other end, which is shown in Figure 5 as bounded by a dashed line. In some embodiments of the present invention, the flex circuit 110 further includes an aperture or cavity 116 to make space for the memory element 78 when the cartridge 90 is installed in the carriage. The flex circuit 110 also includes traces which form a portion of the two wire interface 82, and contacts 118 which connects to the contacts 104 on the cartridge flex circuit 102 which includes the memory element 78.

As shown in Figures 7 and 8, the flex circuit 110 is attached to the carriage such that the cartridge interface portion 114 is on a vertical surface at the rear of the cartridge receptacle. The remainder of the flex circuit 110 is threaded through a horizontally extending slot 120 in the carriage so that the printer I/O end 112 of the flex circuit 110 extends out the back of the carriage to interface with the printer electronics. It will be appreciated by examination of Figures 7 and 8 that when the cartridge 90 is installed into the carriage, the carriage interface portion 98 of the flex circuit 100 on the cartridge will contact the cartridge interface portion 112 of the flex circuit 110 on the carriage. This operation will connect the jet plate 72 to the printer electronics, and will also connect the two wire interface contacts 118 on the carriage to the two wire interface contacts 104 on the cartridge 90.

It can be appreciated that an integrated circuit memory element 78, being positioned on the rear surface 96 of the cartridge 90, could potentially interfere with the flex circuit 110 to flex circuit 100 contact. Figures 4 and 5 illustrate two alternative methods of addressing this issue. In the embodiment of Figure 4, the flex circuit 100 is mounted horizontally, and the memory element is placed so that it extends into the aperture 116 on the carriage flex circuit 110 when the cartridge and carriage are mated. It is accordingly preferable in this embodiment to additionally include an indentation or recess in the carriage body beneath the aperture 116 so that there is sufficient space for the memory element 78 to rest between the cartridge 90 and the carriage without affecting the flex circuit mating. In the embodiment of Figure 5, the flex circuit is mounted vertically, and the memory element 78 is located above the carriage mating portion of the flex circuit 100. In this embodiment, the memory element is positioned vertically so that it resides in the slot 120 above the flex circuit mating region when the cartridge is installed. In this embodiment as well, therefore, the memory element does not interfere with flex circuit mating when the cartridges 90 are installed in the carriage.

Of course, these techniques of avoiding mechanical interference are not required for those cartridge embodiments having a trace configuration memory element as shown in Figure 3. In these embodiments, the flex circuit 110 attached to the print carriage need only be provided with contacts positioned to mate with the output pads 89 so as to receive the multi-bit binary code from the cartridge. In general, the space constraints are also less severe for the provision of a connection between the memory element 79 on the large volume reservoir 77 and the

Another embodiment of the memory element 140 may comprise a bar code label, although this alternative may be disadvantageous in that it is not a memory element which is capable of being written to when the roll is installed in a printer.

Accordingly, in the preferred embodiments of the present invention, a wireless connection is made to the memory element. One preferred embodiment comprises an RF ID tag embedded within the flange 136 of the insert 134. Such a tag has the capacity for receiving and storing information from the printer, as well as transmitting preprogrammed or stored information to the printer, all without a mechanical connection between the tag 140 and the stationary printer stand. The general properties of RF ID tags suitable for use with the present invention may be found in U.S. Patent Nos. 4,857,893 to Carroll and 5,528,222 to Moskowitz et al., the disclosures of each of which are hereby incorporated by reference in their entireties. In addition, commercial RF ID tags suitable for use as described herein are available from for example, as the MICROSTAMP (TM), manufactured by Micron Communications of Boise Idaho.

In one embodiment therefor, the stand (not shown) of the printer includes an RF transceiver (designated 86 in Figure 2) which interacts with the memory element 140 as it passes by with each rotation of the roll 128. In some embodiments, the memory element could be a "passive" RF ID tag device. These devices interact with a magnetic field produced by the RF transceiver 86, and reflect a modulated signal which can vary depending on pre-programmed information stored in the memory element 140. The RF transceiver 86 receives this modulated signal and can read the stored information by analyzing the reflected signal. This system may be used to store information about the media itself, including its type, coating information, color, thickness, length, manufacturer and manufacturing date, lot number, etc. This system has the advantage that such passive read only RF ID tags are small and inexpensive devices.

The preferred embodiment includes a writable RF ID tag as the memory element 140. While such devices include more complex circuitry than the passive tags described above, they offer advantages such as storing information concerning the amount of media from the roll that has been used. In a manner analogous to the analysis of information stored in the cartridge memory element 78 regarding the amount of ink expelled, this media information can be used to alert the user that there is insufficient media to product the next print. Keeping track of the amount of media that has been used can be done in a variety of ways. The printer can keep track of how much paper has been advanced through the platen while the roll 128 has been installed. Alternatively, a mechanism can be incorporated into the stand to count how many revolutions the roll 128 has revolved since installation. This mechanism may comprise, for example, a reed switch mounted to the stand which is actuated each time a boss or tab (not shown) on the roll insert 134 passes the switch. Alternatively, a piece of reflective tape placed on the flange 136 of the roll insert 134 could be sensed optically by an LED/light sensor mechanism in the stand. With this system, the number of revolutions performed is stored in the memory element 140.

Storage of this information in the memory element 140 (rather than simply in internal printer memory) provides a significant advantage. Thus, the roll may be removed before it is empty if it is desired to use the printer with other media, or the roll may be removed from one printer and used on a different printer. In these cases, the

WHAT IS CLAIMED IS:

1. An ink jet printer capable of automatically optimizing printing operations according to sensed consumable information, said ink jet printer comprising:

a printer frame providing printer control electronics for controlling print operations, said printer frame having mounted thereon a moveable print carriage and a roll of print media;

an ink jet cartridge mounted on said moveable print carriage;

an ink jet cartridge memory element, wherein said ink jet cartridge memory element is mounted to said ink jet cartridge, wherein said ink jet cartridge memory element stores information regarding ink in said ink jet cartridge, and wherein said ink jet cartridge memory element is coupled to said printer control electronics;

a print media memory element mounted to said roll of print media and coupled to said printer control electronics, wherein said printer control electronics is configured to control printer operations in response to data received from said ink jet cartridge memory element and said print media memory element.

2. The ink jet printer of Claim 1, additionally comprising a temperature sensor coupled to said printer control electronics.

3. The ink jet printer of Claim 1, additionally comprising a humidity sensor coupled to said printer control electronics.

4. An ink jet printer comprising:

a humidity sensor having an output representing ambient humidity;

a temperature sensor having an output representing ambient temperature; and

printer control electronics coupled to said humidity sensor output and said temperature sensor output, wherein said printer control electronics is configured to calculate a dew point from said outputs and to control printer operations in response to said dew point.

5. The ink jet printer of Claim 4, wherein said printer control electronics controls print speed in response to said calculated dew point.

6. An ink jet printer having a roll of print media mounted thereon, wherein said roll of print media comprises a memory element.

7. The ink jet printer of Claim 6, wherein said memory element is a writable memory element.

8. The ink jet printer of Claim 7, wherein said ink jet printer comprises a wireless transceiver for reading from and writing to said memory element.

9. The ink jet printer of Claim 8, wherein said wireless transceiver is mounted in a printer stand portion of said ink jet printer such that said writable memory element passes proximate to said wireless transceiver during a rotation of said roll of print media.

10. The ink jet printer of Claim 6, wherein said memory element stores information indicating the compatibility of said print media with at least one ink composition.

23. An ink jet printer capable of automatically optimizing printing operations according to sensed consumable information, said ink jet printer comprising an ink jet cartridge, a moveable print carriage, and a communication interface between said ink jet cartridge and said moveable print carriage, said communication interface comprising:

a first flex circuit mounted on said moveable print carriage, said first flex circuit comprising a plurality of electrical contacts;

a second flex circuit mounted on said ink jet cartridge, said second flex circuit comprising a plurality of electrical contacts configured to mate with a first portion of said plurality of electrical contacts on said first flex circuit when said ink jet cartridge is installed in said moveable print carriage;

a third flex circuit mounted on said ink jet cartridge, said third flex circuit comprising a memory element and a plurality of electrical contacts, wherein said third flex circuit is mounted to said cartridge such that (1) said plurality of electrical contacts are configured to mate with a second portion of said plurality of electrical contacts on said first flex circuit, and (2) said memory element is positioned to avoid interfering with the mating of said pluralities of electrical contacts on said first, second, and third flex circuits when said ink jet cartridge is installed in said moveable print carriage, whereby said communication interface is effective for transferring data from said memory element to processing circuitry in said ink jet printer so that print operations may be optimized in response to said data.

24. The ink jet printer of Claim 23, additionally comprising:

a roll of print media;

a second memory element attached to said roll of print media, whereby print operations are optimized in response to data stored in said second memory element.

25. An ink jet printer comprising an ink jet cartridge, a moveable print carriage, and a communication interface between said ink jet cartridge and said moveable print carriage, said communication interface comprising:

a first flex circuit mounted on said moveable print carriage, said first flex circuit comprising a plurality of electrical contacts;

a second flex circuit mounted on said ink jet cartridge, said second flex circuit comprising a plurality of electrical contacts configured to mate with a first portion of said plurality of electrical contacts on said first flex circuit when said ink jet cartridge is installed in said moveable print carriage;

a third flex circuit mounted on said ink jet cartridge, said third flex circuit comprising a memory element and a plurality of electrical contacts, wherein said third flex circuit is mounted to said cartridge such that (1) said plurality of electrical contacts are configured to mate with a second portion of said plurality of electrical contacts on said first flex circuit, and (2) said memory element is positioned to avoid interfering with the mating of said pluralities of electrical contacts on said first, second, and third flex circuits when said ink jet cartridge is installed in said moveable print carriage.

26. The ink jet printer of Claim 25, wherein said memory element is positioned to reside in a cavity provided in said first flex circuit.

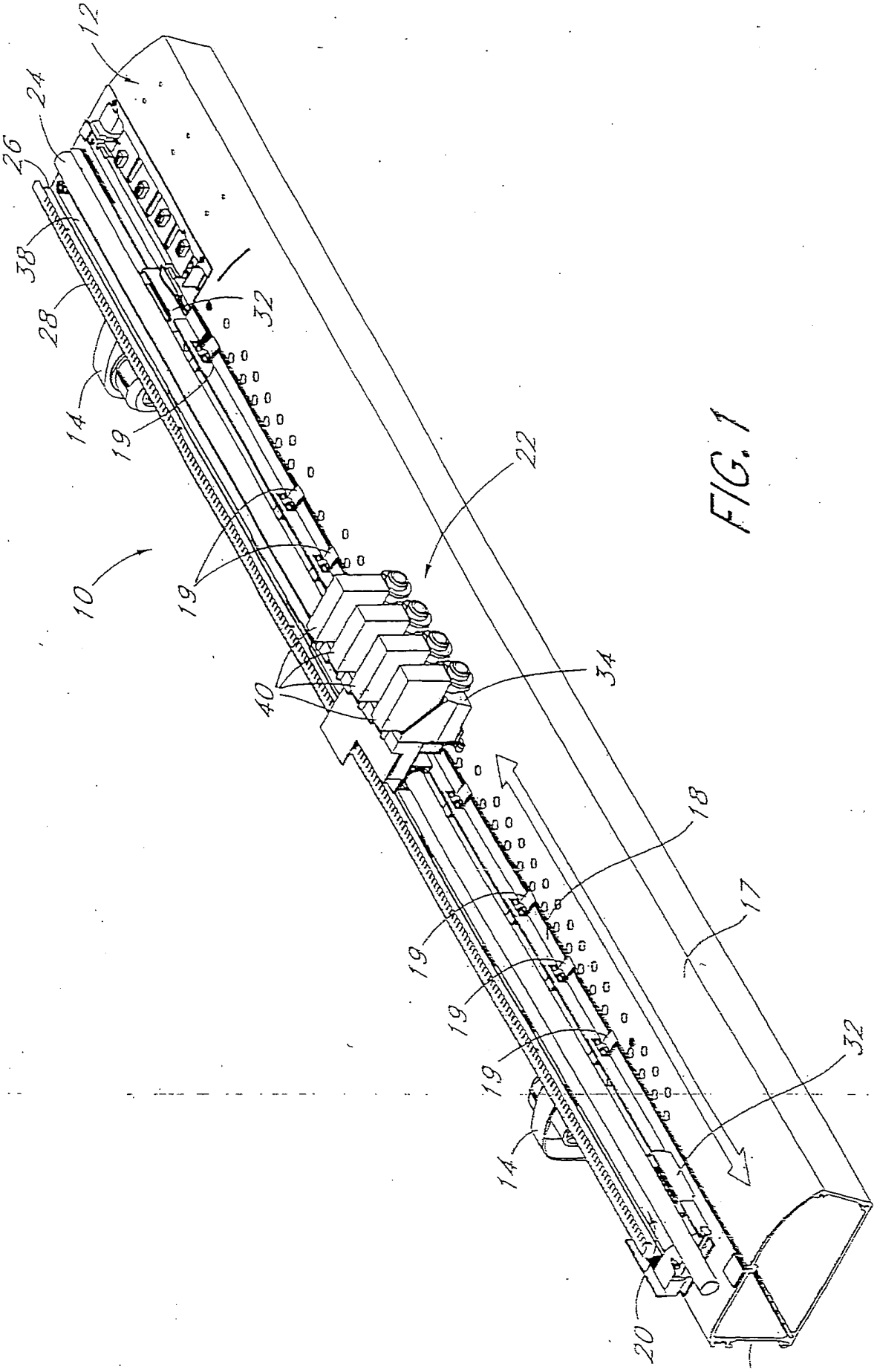


FIG. 1

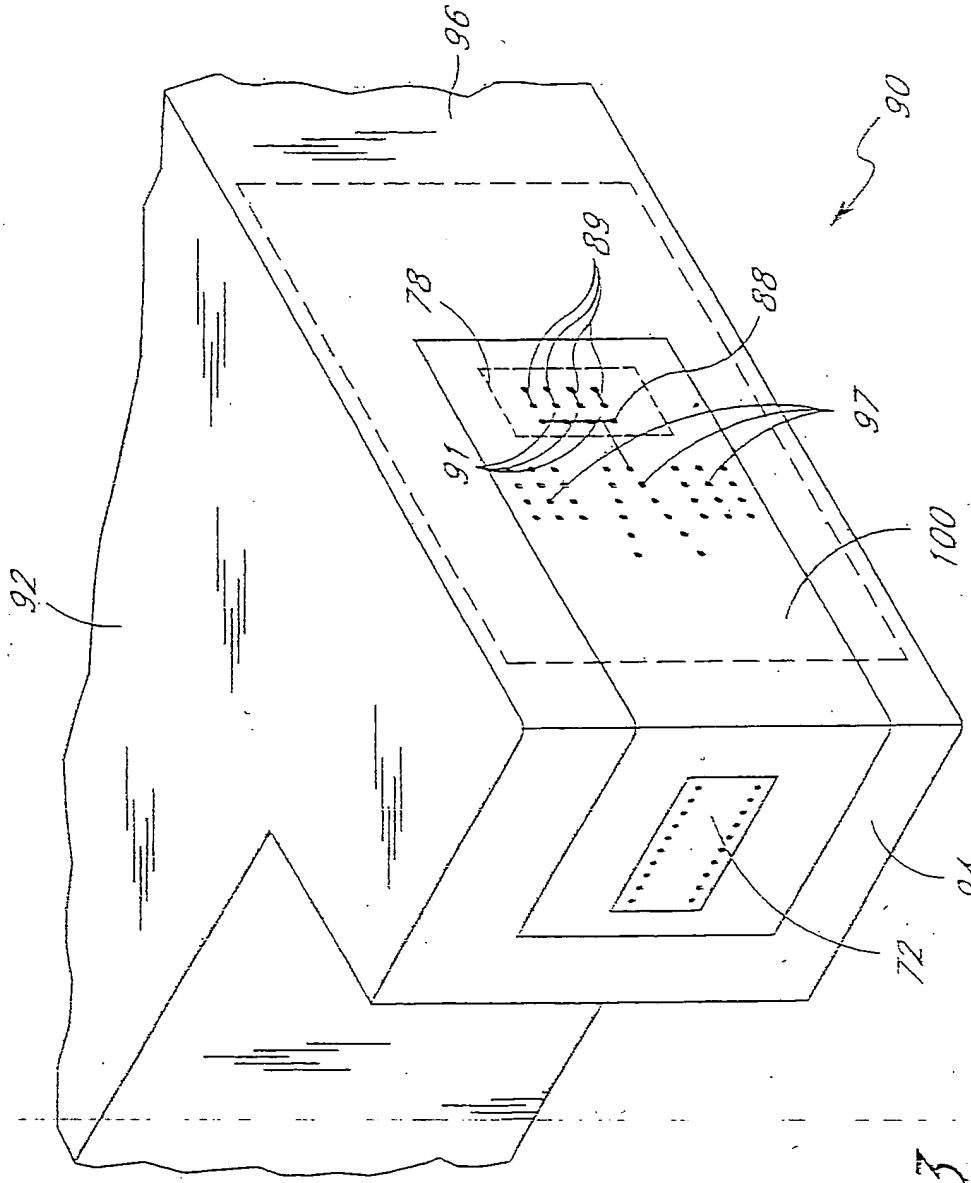


FIG. 3

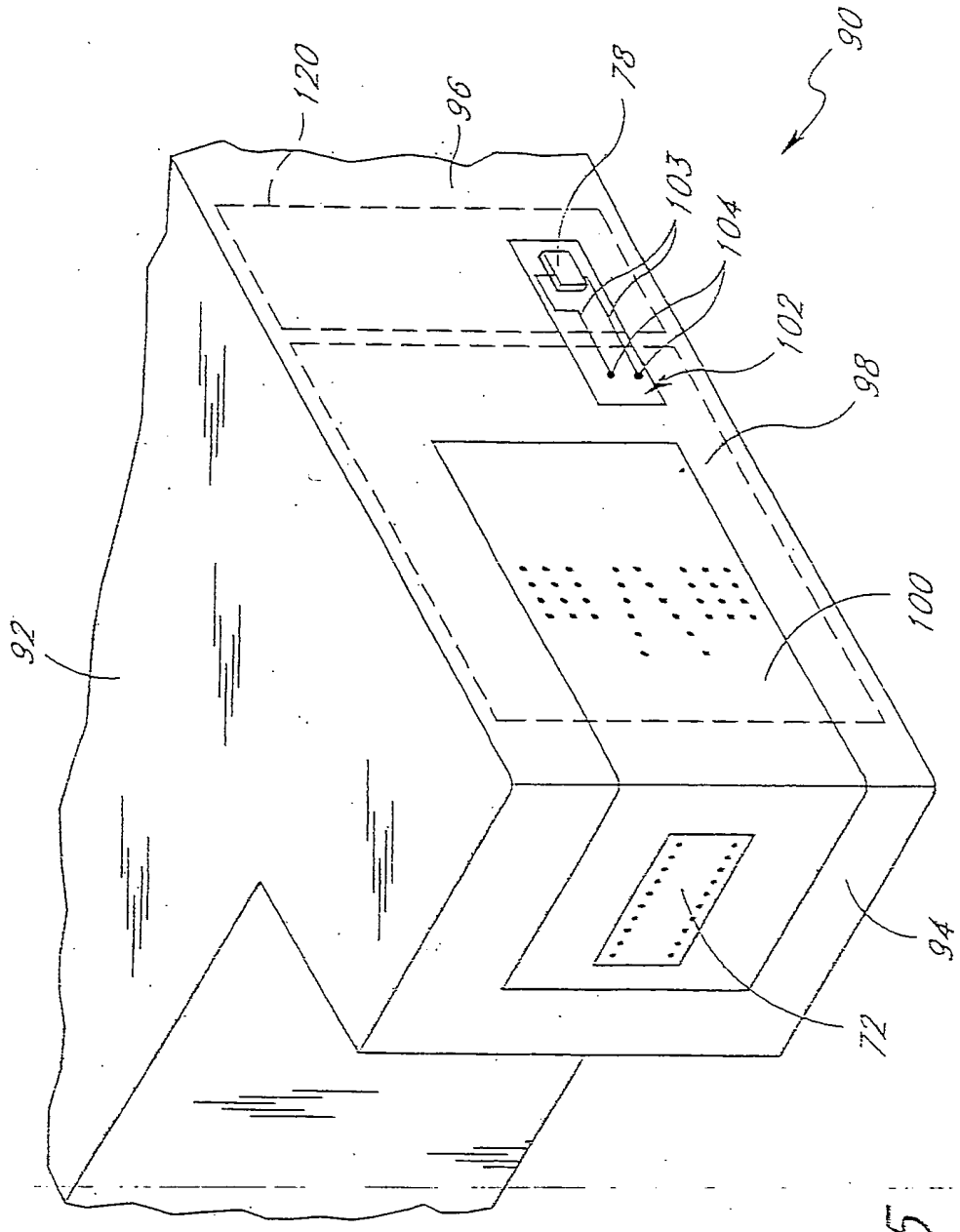


FIG. 5

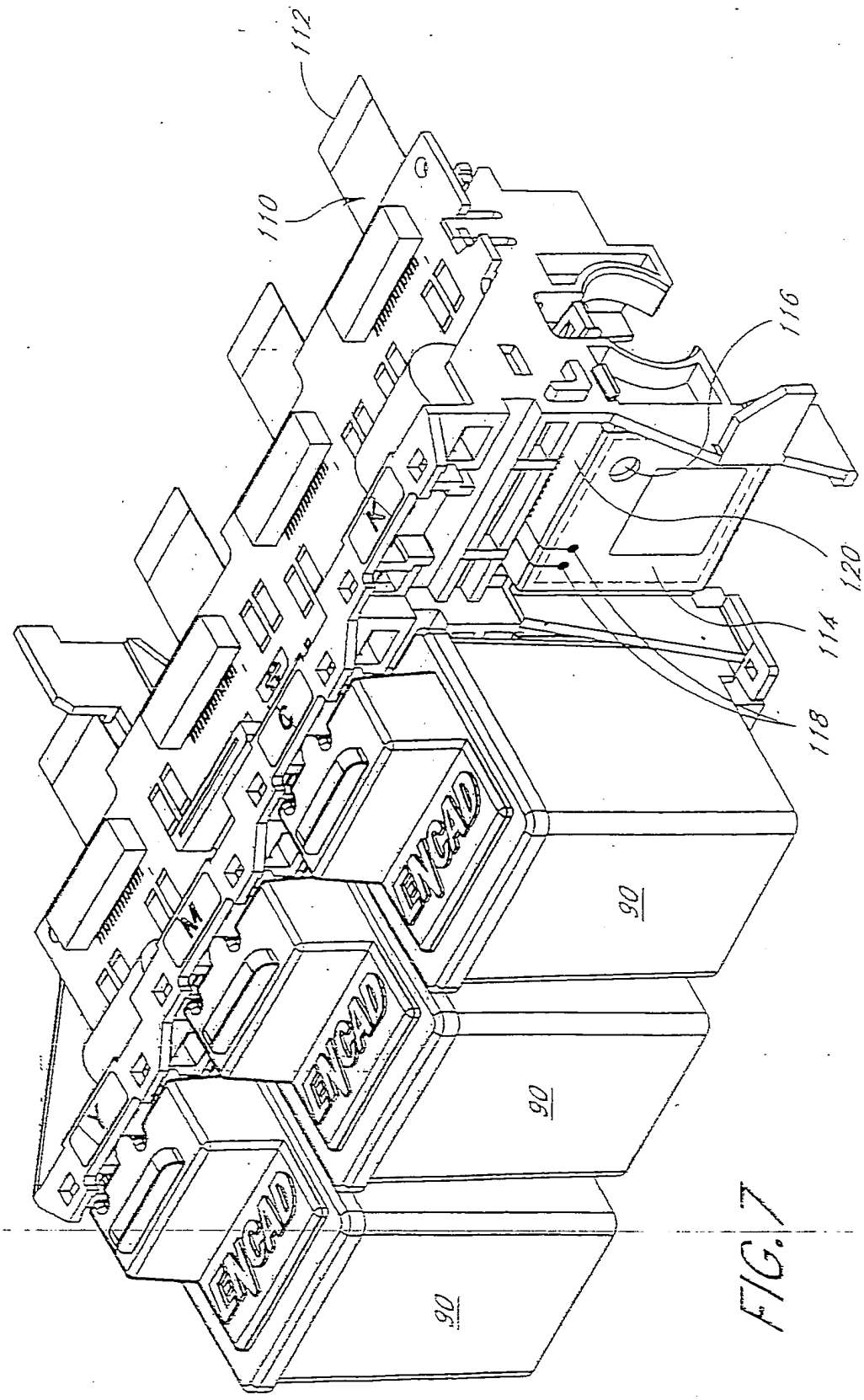
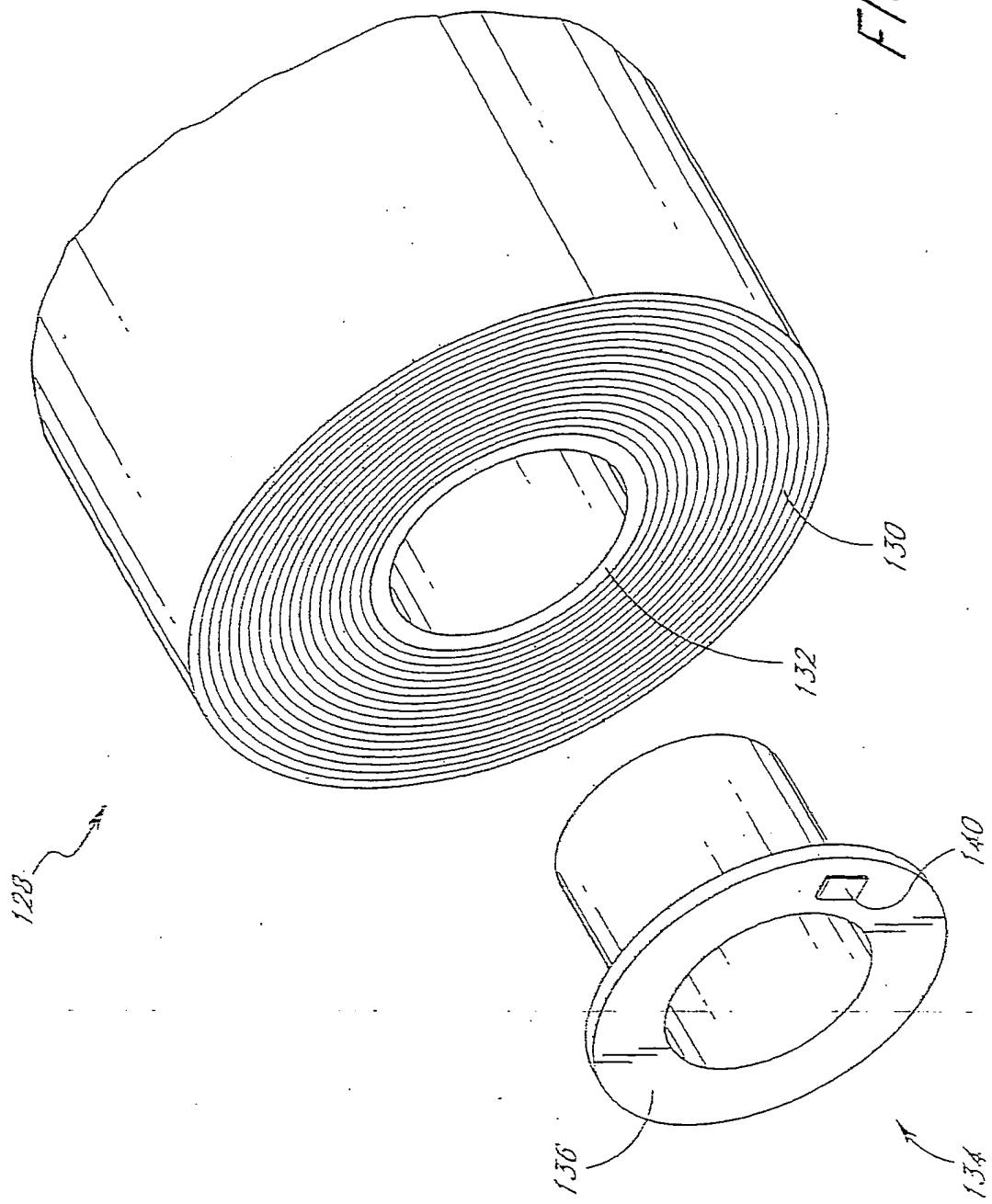


FIG. 7

FIG. 9



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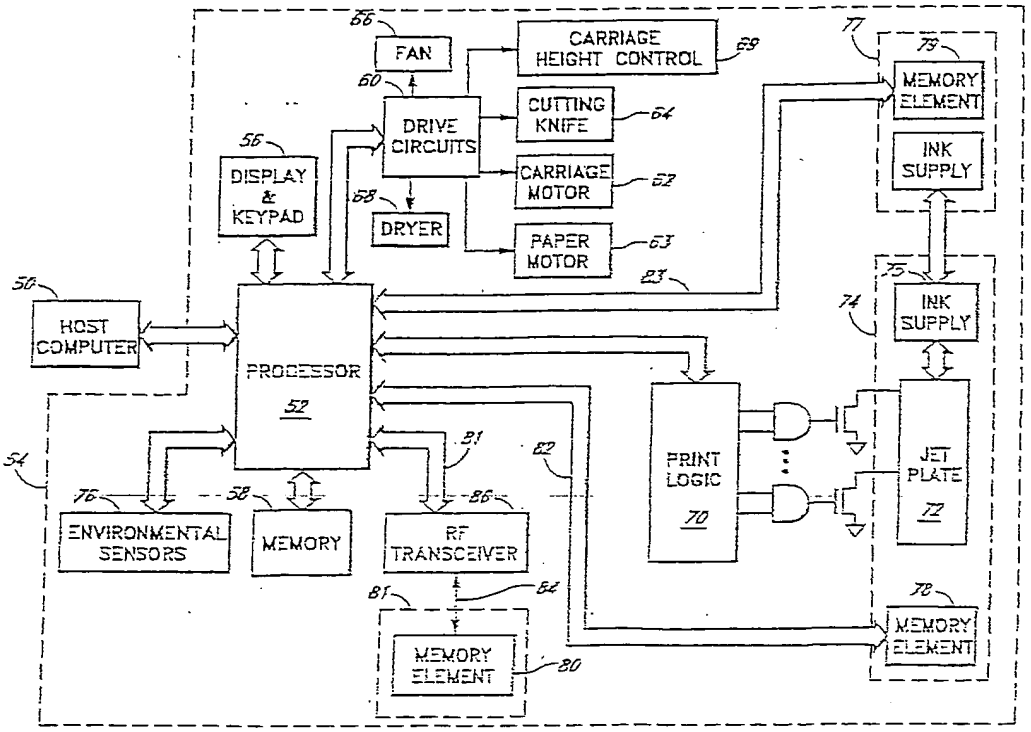
(54) Title: INTELLIGENT PRINTER COMPONENTS AND PRINTING SYSTEM



(57) Abstract

An ink jet printer with intelligent components includes an ink jet cartridge (74) and a roll of print media (81), each of which incorporate memory elements (78, 80). Environmental sensors (76) such as temperature and humidity sensors may also be provided. Data from the memory elements (78, 80) and environmental sensors (76) is used to optimize printer operations, and to provide additional information to

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B41J2/01 B41J2/17

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 14989 A (LASERMASTER CORP) 23 May 1996 see page 14, line 16 - page 18, line 10 see page 54, line 7 - page 56, line 9 see page 78, line 2 - page 80, line 14; figures 1-3,26,30,32 & US 5 592 202 A (ERICKSON PAUL R) 7 January 1997 see column 29, line 5-26; figure 1	1-3,18
A	EP 0 668 165 A (HEWLETT PACKARD CO) 23 August 1995 cited in the application see abstract; figure 2	1-3,18

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search	Date of mailing of the international search report
20 July 1998	18. 11. 98

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,

Authorized officer
Widmaier W

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-3,18

Ink jet printer and ink jet printing method with memory elements on the ink cartridge and on the paper roll and printer control in accordance with the data of these memories.

2. Claims: 4,5,30,31

Ink jet printer and ink jet printing method with calculation of a dew point on the basis of signals from a temperature sensor and a humidity sensor.

3. Claims: 6-11

Ink jet printer with a paper roll which comprises a memory element.

4. Claims: 12,13

Paper roll with a memory element which stores information indicating the compatibility of print medium and ink.

5. Claims: 14,15

Paper roll with a memory element which stores information indicating the remaining length of the print medium.

6. Claims: 16,17

Paper roll with a memory element which stores information indicating the thickness of the print medium.

7. Claims: 19-21

Ink jet cartridge with a flex circuit whose circuit traces define a binary code.

8. Claims: 22-26

Ink jet cartridge with a flex circuit on which a memory element is mounted.

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		US 5592202 A	07-01-1997
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